

WHAT IS CLAIMED IS:

2           1. A method for handling interference that is  
3     disturbing a desired signal, comprising the steps of:  
4                 receiving a signal, the signal including a desired  
5     component and an interference component;  
6                 estimating the interference component to produce  
7     an interference component estimate;  
8                 applying the interference component estimate to the  
9     signal to produce a desired component estimate;  
10                forwarding the desired component estimate;  
11                feeding back the desired component estimate; and  
12                using the desired component estimate to adjust the  
13     interference component estimate.

1           2. The method according to claim 1, wherein the  
2     interference comprises "bumblebee" interference.

1           3.    The method according to claim 2, wherein the  
2    "bumblebee" interference comprises a signal oscillating at  
3    approximately 217 Hz in a wireless network operating in  
4    accordance with the Global System for Mobile Communications  
5    (GSM).

1           4.    The method according to claim 1, wherein said step  
2    of receiving a signal comprises the step of receiving the  
3    signal directly or indirectly from a microphone of a mobile  
4    station.

1           5.    The method according to claim 1, wherein said step  
2    of estimating the interference component to produce an  
3    interference component estimate comprises the step of  
4    bandpass filtering the signal in a predetermined frequency  
5    range that is associated with the interference component.

1           6.    The method according to claim 1, wherein said step  
2   of estimating the interference component to produce an  
3   interference component estimate comprises the step of  
4   identifying a fundamental frequency of the interference  
5   component.

1           7.    The method according to claim 1, wherein said step  
2   of estimating the interference component to produce an  
3   interference component estimate comprises the step of  
4   generating harmonics of a fundamental frequency of the  
5   interference component.

1           8.    The method according to claim 1, wherein said step  
2   of estimating the interference component to produce an  
3   interference component estimate comprises the step of  
4   generating a replica of the interference component in the  
5   frequency domain using harmonics of a fundamental frequency  
6   of the interference component.

1           9.    The method according to claim 8, wherein said step  
2   of estimating the interference component to produce an  
3   interference component estimate further comprises the step  
4   of forwarding a time domain version of the replica as the  
5   interference component estimate.

1           10.   The method according to claim 8, wherein said step  
2   of generating a replica of the interference component in the  
3   frequency domain using harmonics of a fundamental frequency  
4   of the interference component comprises the step of  
5   determining a weight for each addend of a Fourier series  
6   expansion, each addend corresponding to a harmonic of the  
7   fundamental frequency of the interference component.

1           11.   The method according to claim 1, wherein said step  
2   of applying the interference component estimate to the signal  
3   to produce a desired component estimate comprises the step  
4   of subtracting the interference component estimate from the  
5   signal to produce the desired component estimate.

1           12. The method according to claim 1, wherein said step  
2 of forwarding the desired component estimate comprises the  
3 step of forwarding the desired component estimate for further  
4 pre-transmission processing in a mobile station.

1           13. The method according to claim 1, wherein said step  
2 of feeding back the desired component estimate comprises the  
3 step of submitting the desired component estimate to a  
4 plurality of bandpass filters, each bandpass filter of the  
5 plurality of bandpass filters being centered on a harmonic  
6 frequency of a fundamental frequency of the interference  
7 component.

1           14. The method according to claim 1, wherein said step  
2 of using the desired component estimate to adjust the  
3 interference component estimate comprises the step of  
4 adjusting a plurality of weights, each weight of the  
5 plurality of weights corresponding to an addend of a Fourier  
6 series sum, each addend of the Fourier series sum  
7 corresponding to a harmonic of a fundamental frequency of the  
8 interference component.

1           15. An arrangement for handling interference,  
2 comprising:

3           a fundamental frequency identifier, said  
4 fundamental frequency identifier adapted to accept a version  
5 of a signal, the signal including a desired component and an  
6 interference component, said fundamental frequency identifier  
7 further adapted to produce a fundamental frequency of the  
8 interference component;

9           a harmonic generator, said harmonic generator  
10 adapted to receive the fundamental frequency of the  
11 interference component and to generate harmonics thereof;

12           an interference generator, said interference  
13 generator adapted to receive the generated harmonics and to  
14 create a replica of the interference component; and

15           a difference determiner, said difference determiner  
16 adapted to receive the signal and the replica of the  
17 interference component and to determine the difference  
18 between the signal and the replica of the interference  
19 component to produce an estimate of the desired component.

1           16. The arrangement according to claim 15, further  
2 comprising:

3                 a bandpass filter, said bandpass filter having a  
4 frequency range set responsive to an expected value of the  
5 fundamental frequency of the interference component, said  
6 bandpass filter adapted to receive the signal and to produce  
7 the version of the signal, the version of the signal being  
8 reduced in frequency spectrum in accordance with the  
9 frequency range of the bandpass filter.

1           17. The arrangement according to claim 15, wherein said  
2 fundamental frequency identifier comprises a phase locked  
3 loop (PLL).

1           18. The arrangement according to claim 15, wherein said  
2 interference generator is further adapted to create the  
3 replica of the interference component in the frequency domain  
4 using determined weights for a Fourier series expansion, the  
5 replica of the interference component comprising an  
6 interference component estimate.



1           19. The arrangement according to claim 15, wherein said  
2 difference determiner comprises a summer, said summer adapted  
3 to add a negative of the replica of the interference  
4 component to the signal to produce the estimate of the  
5 desired component.

1           20. The arrangement according to claim 15, further  
2 comprising:  
3           a plurality of bandpass filters, each bandpass  
4 filter of said plurality of bandpass filters being centered  
5 on a harmonic of the harmonics of the interference component,  
6 said plurality of bandpass filters adapted to receive the  
7 estimate of the desired component and to produce a plurality  
8 of bandpass filtered outputs, each bandpass filtered output  
9 of the plurality of bandpass filtered outputs having a  
10 frequency spectrum centered around one of the harmonics of  
11 the interference component.

1           21. The arrangement according to claim 20, wherein said  
2 interference generator is further adapted to adjust weights  
3 of a frequency domain sum of addends responsive to the  
4 plurality of bandpass filtered outputs.

1           22. The arrangement according to claim 15, wherein the  
2 arrangement comprises at least part of a mobile station.

1           23. The arrangement according to claim 15, wherein at  
2 least part of at least one of said fundamental frequency  
3 identifier, said harmonic generator, said interference  
4 generator, and said difference determiner comprises software  
5 code.

1           24. A system for handling interference that is  
2   disturbing a desired signal, comprising:  
3           means for receiving a signal, the signal including  
4   a desired component and an interference component;  
5           means for estimating the interference component to  
6   produce an interference component estimate;  
7           means for applying the interference component  
8   estimate to the signal to produce a desired component  
9   estimate;  
10          means for feeding back the desired component  
11   estimate; and  
12          means for using the desired component estimate to  
13   adjust the interference component estimate.

1           25. A method for handling interference that is  
2     disturbing a desired signal, comprising the steps of:  
3           providing a signal, the signal including a desired  
4     component and an interference component;  
5           filtering the signal to produce a bandpass filtered  
6     signal, the bandpass filtered signal having a frequency range  
7     selected responsive to an expected fundamental frequency of  
8     the interference component;  
9           determining a fundamental frequency of the  
10    interference component from the bandpass filtered signal;  
11           generating harmonics of the fundamental frequency  
12    of the interference component;  
13           estimating the interference component to produce  
14    an interference component estimate using the fundamental  
15    frequency and the generated harmonics; and  
16           applying the interference component estimate to the  
17    signal to produce a desired component estimate.

1           26. The method according to claim 25, further  
2     comprising the steps of:

3                 feeding back the desired component estimate through  
4     a plurality of bandpass filters to produce a plurality of  
5     bandpass filtered outputs; and

6                 using the plurality of bandpass filtered outputs  
7     to adjust the interference component estimate.

1           27. The method according to claim 25, further  
2     comprising the steps of:

3                 feeding back the desired component estimate through  
4     an error determiner to determine an error of the interference  
5     component estimate; and

6                 using the error to adjust the interference  
7     component estimate.

1           28. The method according to claim 27, further  
2 comprising the step of:

3                 detecting an absence of voice activity in the  
4 signal; and

5                 wherein said steps of feeding back the desired  
6 component estimate through an error determiner to determine  
7 an error of the interference component estimate and using the  
8 error to adjust the interference component estimate are  
9 executed responsive to the detection of the absence of voice  
10 activity in said step of detecting an absence of voice  
11 activity in the signal.

1           29. The method according to claim 27, wherein said step  
2 of using the error to adjust the interference component  
3 estimate comprises the step of iteratively adjusting weights  
4 in a Fourier series expansion.

1           30. An arrangement for handling interference,  
2 comprising:

3           a filter, said filter receiving a signal as input,  
4 said filter outputting a filtered version of the signal, the  
5 signal including first and second components;

6           a frequency determiner, said frequency determiner  
7 coupled to said filter and receiving the filtered version of  
8 the signal as input, said frequency determiner outputting a  
9 frequency of the filtered version of the signal;

10          a harmonic generator, said harmonic generator  
11 coupled to said frequency determiner and receiving the  
12 frequency of the filtered version of the signal as input,  
13 said harmonic generator outputting a plurality of harmonics  
14 of the frequency of the filtered version of the signal;

15          a component generator, said component generator  
16 coupled to said harmonic generator and receiving the  
17 plurality of harmonics as input, said component generator  
18 outputting an estimate of the second component of the signal;

19          a difference determiner, said difference determiner  
20 coupled to said component generator and receiving the

21 estimate of the second component and the signal as inputs,  
22 said difference determiner determining a difference between  
23 the signal and the estimate of the second component, the  
24 difference comprising an estimate of the first component of  
25 the signal.

1 31. The arrangement according to claim 30, further  
2 comprising:

3 a plurality of filters, said plurality of filters  
4 receiving the estimate of the first component as input, said  
5 plurality of filters producing a plurality of respective  
6 filtered outputs; and

7 wherein said component generator adjusts the  
8 estimate of the second component of the signal responsive to  
9 the plurality of respective filtered outputs in the frequency  
10 domain using at least one Fourier series expansion.



1           32. The arrangement according to claim 30, further  
2 comprising:

3           an error determiner, said error determiner  
4 receiving the estimate of the first component and the signal  
5 as inputs, said error determiner determining an error output;  
6 and

7           wherein said component generator adjusts the  
8 estimate of the second component of the signal responsive to  
9 the error output in the frequency domain using at least one  
10 Fourier series expansion when the first component is  
11 approximately zero.

1           33. A mobile station for handling bumblebee  
2 interference, comprising:

3                 an antenna;

4                 a transmitting part connected to said antenna, said  
5 transmitting part including a microphone having a microphone  
6 signal, the microphone signal infected by the bumblebee  
7 interference;

8                 a receiving part connected to said antenna;

9                 a processing unit, said processing unit adapted to  
10 receive at least a version of the microphone signal; and

11                wherein said processing unit is configured to  
12 estimate the bumblebee interference based, at least in part,  
13 on an expected fundamental frequency of the bumblebee  
14 interference and the at least a version of the microphone  
15 signal, said processing unit being further configured to  
16 subtract the estimate of the bumblebee interference from the  
17 at least a version of the microphone signal.